Research Trends

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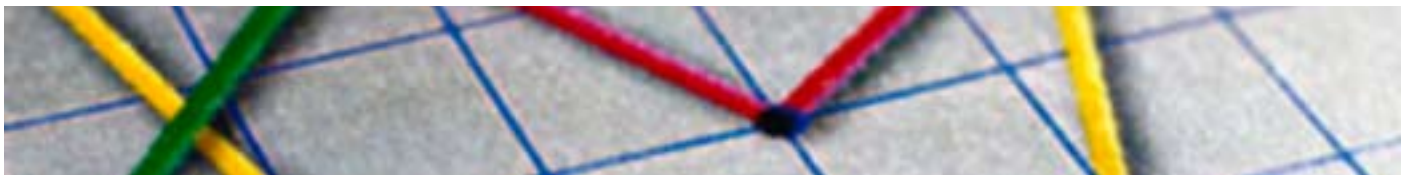

Analyzing the multidisciplinary landscape

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Many of today's most pressing scientific challenges, such as identifying alternative energy sources, require a multidisciplinary approach. However, traditional methods for assessing research output cannot adequately measure multidisciplinary research output.

Current methods of organizing, and thus analyzing, science are based on journal categories. Yet, since journals are based on single disciplines, this classification system cannot capture the changing landscape. This means it is impossible for research executives and government policymakers to gain insight into which institutions, countries and regions are leading in such fields as alternative energy.

However, research executives need accurate research performance information to identify areas of research strengths and make strategic decisions. Developing an accurate picture of how universities and countries are performing is critical to advancing the frontiers of science.

A new way to measure multidisciplinary impact

Senior Development Advisors Kevin Boyak and Dick Klavans, together with Elsevier, have developed a new method of measuring output in multidisciplinary research. Based on co-citation analysis, SciVal Spotlight displays research performance from an interdisciplinary perspective.

Using Scopus as its underlying data source, SciVal Spotlight draws upon 5.6 million research papers published between 2003 and 2007, along with another two million reference papers that these publications cite heavily. This content was divided into about 80,000 paradigms, each of which is centered on a separate topic (e.g. alternative energy) in science.

These paradigms were used to identify an institution's distinctive competencies. Researchers tend to focus within a unique set of related paradigms, which form natural clusters based on the research networks at their institution. These clusters can be seen as the institution's distinctive competencies, and are the areas in which the institution is a research leader. One of the unique features of this method is that it can identify those distinctive competencies that link multiple disciplines within an institution, indicating that research within the university is not being done in isolated silos. If work does not appear as part of a distinctive competency, this does not mean that it is not good work, but rather that it is isolated, and not part of a larger network.

An institute is identified as a research leader if it displays substantial activity and impact in the topics associated with the paradigm.

True leadership is in distinctive competencies

Using this new methodology to measure which institutions, countries and regions are research leaders in alternative energy-related science gave some surprising and insightful results (see box for method).

At an institute-level, the top-10 world institutes are almost all in the United States, with Germany a close second (see Figure 1). In fact, the United States is ahead in all of the topic groups on a single-country basis; however, the only area in which it has overwhelming leadership is in environmentally related research. In fuel cells and solar energy, leadership is more diffuse, and Germany and China are significant players in these two fields.

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Leaders in alternative-energy research

Alternative-energy research is, by its very nature, multidisciplinary, and any attempt to identify leaders in this field must take this into account. In order to rank leaders in alternative-energy research, Boyak and Klavans first identified alternative energy-related paradigms using search terms from relevant websites. They discovered that 1,100 paradigms contained alternative energy research, and divided these into three equally distributed topic groups:

1. Solar/PV
2. Fuel cells
3. Environmentally related (efficiency + renewable + biomass + biodiesel + biofuel + nuclear + wind + cogeneration + clean coal + carbon + bioenergy + security + hydroelectric + geothermal)

They then counted the alternative-energy papers for over 3,000 major academic and government players within the global research community, ranked them according to output and calculated distinctive competencies for each of the top-50 institutions on the list.

To rank the research leaders in this field (see Figure 1), they found where the 1,100 paradigms from the three topic groups belonged to a distinctive competency and counted the number of alternative-energy papers that were in distinctive competencies for each university/laboratory.

This information was aggregated to identify country (see Figures 2, 3 and 4) and regional leaders in alternative-energy research.

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In fact, while Germany's total number of papers remains lower than the United States', its percentage of papers in distinctive competencies in both solar-energy and fuel-cells research is higher. This indicates that Germany is a formidable competitor in these areas, particularly in solar energy, where it has 335 papers in distinctive competencies compared with 454 for the United States.

Identifying distinctive competencies rather than simply relying on citation counts shows where competition could come from in the future. While Germany may not yet be leading the United Stated on alternative-energy research, it is certainly developing deep expertise in a wide range of disciplines, which could result in breakthroughs in the near future.

If our most urgent scientific challenges, such as alternative-energy, require a multidisciplinary approach, then we urgently need to find ways of measuring output in these areas. Future breakthroughs in such areas are expected to emerge from the institutes and countries drawing on the widest range of their research capabilities to answer specific questions. And this methodology helps us see where those breakthroughs are likely to emerge.

Useful links:

SciVal Spotlight
Research leadership redefined – measuring performance in a multidisciplinary landscape. Listen to the webinar here
USA Today, 'US institutes lead in environmental research expertise'

	Institution	Country	Total
1	NASA Goddard Space Flight Center	US	309
2	National Renewable Energy Laboratory	US	271
3	Hahn-Meitner-Institut	DE	240
4	Forschungszentrum Julich	DE	234
5	Pennsylvania State University	US	168
6	National Oceanic and Atmospheric Administration	US	121
7	University of California at Irvine	US	101
8	Osaka University	JP	97
9	California Institute of Technology	US	97
10	Harvard University	US	84

Figure 1– Top-10 institutions for alternative-energy research

Country	Total Papers	Papers in DCs	% in DCs
United States	893	454	51%
Japan	455	149	33%
Germany	370	335	91%

Figure 2 – Top-three countries for solar/photovoltaic research

Country	Total papers	Papers in DCs	% in DCs
United States	1006	377	38%
China	574	157	27%
Japan	531	94	18%

Figure 3 – Top-three countries for fuel-cells research

Country	Total papers	Papers in DCs	% in DCs
United States	1997	797	40%
China	425	75	18%
Japan	216		0%

Figure 4 –Top-three countries for environmentally related energy research